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DESCRIPTION

VALVE TIMING ADJUSTING DEVICE

TECHNICAL FIELD

[0001]

The present invention relates to a valve timing adjusting device that controls opening and closing timings of an intake valve or exhaust valve of an internal combustion engine such as engine (hereinafter, referred to as engine).

BACKGROUND ART

[0002]

A conventional valve timing adjusting device is composed of: a first rotor that integrally fixes the following three parts, a housing having the bearing of a camshaft, a case internally having a plurality of shoes projecting therefrom and having hydraulic chambers formed between the shoes, and a cover covering the hydraulic chambers, and the first rotor that rotates integrally with a crank shaft; and a second rotor that has a plurality of vanes each dividing the hydraulic chamber into an advanced-angle hydraulic chamber and a retarded-angle hydraulic chamber, can rotate through a predetermined angle within the first rotor, and is integrally fixed with an intake or exhaust camshaft. It is arranged that these hydraulic chambers be supplied with and exhausted of the oil pressure of an oil pump supplying oil to the sliding portion of the engine,

and this oil pressure control the relative position of the second rotor with respect to the first rotor.

[0003]

In general, this type of valve timing adjusting device uses a compression spring or a torsion spring as an energizing means for energizing the second rotor. When the compression spring is used therefor, as disclosed by JP-A-2004-150278, for example, (1) a holder is inserted in the shoe of the first rotor or the vane of the second rotor, and the compression spring is placed in a hole formed in the holder; or (2) a groove is formed in the shoe of the first rotor or the vane of the second rotor, and the compression spring is placed in the groove. This groove is usually provided therein on the cover side thereof in consideration of the assembly.

[0004]

Patent Reference: JP-A-2004-150278

[0005]

The conventional valve timing adjusting device is arranged as mentioned above. For this reason, when the configuration (1) described above is used, the oil also flows in between the holder and the cover. Thereby, the area in which the cover receives the oil pressure becomes the area of the usual advanced (or retarded)-angle hydraulic chamber, to which the area of the holder is added. As a result, there is a problem that when the cover warped because of an increase of such an oil-pressure receiving area, to thereby make a gap between the cover and the case, the oil leak therebetween is caused.

[0006]

In the configuration (2) described above, in general, the groove where the compression spring is placed is provided therein on the cover side thereof in view of the assembly. Therefore, there is a problem that in the event that the cover is subjected to the oil-pressure to be warped, similarly to the case of the above configuration (1), there occurs a gap between the cover and the case, which may cause an oil leak therebetween. Moreover, there is a problem that, when the compression spring in the configuration (2) is employed, the seats at the two ends of the spring cannot be held parallel at the time of its expansion and contraction, which may cause the spring to excessively bend to sometimes damage the function of the spring.

[0007]

The present invention has been accomplished to solve the above-mentioned problem. An object of the present invention is to provide a valve timing adjusting device in which the oil leak caused by the flexure of the cover is prevented and which smoothly operates.

DISCLOSURE OF THE INVENTION

[0008]

The valve timing adjusting device according to the present invention, includes: a first rotor that integrally fixes a housing having the bearing of a camshaft, a case internally having a plurality of shoes projecting therefrom and having hydraulic chambers formed between the shoes, and a cover

covering the hydraulic chambers, and the first rotor that rotates integrally with a crank shaft; and a second rotor that has a plurality of vanes each dividing the hydraulic chamber into an advanced-angle hydraulic chamber and a retarded-angle hydraulic chamber, can rotate through a predetermined angle within the first rotor, and is integrally fixed with an intake or exhaust camshaft; wherein one end of energizing means for adjusting the relative position between the first rotor and the second rotor is accommodated in the groove provided in the side of the shoe opposite to the housing, and the other-end of the energizing means is accommodated in a holes or a groove provided in the vane of the second rotor.

[0009]

In this way, the one end of the energizing means for adjusting the relative position between the first rotor and the second rotor is accommodated in the groove provided in the side of the shoe opposite to the housing, and the other end thereof is accommodated in the groove or hole provided in the vane of the second rotor. As a result, the housing has a sufficient thickness and sufficient strength as compared with that of the cover, which never causes an oil leak due to bending or warping of the housing caused by an oil pressure.

Further, no received area of the oil pressure to the cover is enlarged, and thereby the warp of the cover is alleviated, which enables to reduce the oil leak. Furthermore, reduction of the received area of the oil pressure to the cover allows a thin cover or a cover with a low strength to enlarge the

applicability.

BRIEF DESCRIPTION OF THE DRAWINGS

[0010]

FIG. 1 is an axial sectional view of the internal configuration of a valve timing adjusting device in accordance with Embodiment 1 of the present invention, taken along the line A-A of FIG. 3;

FIG. 2 is an axial sectional view of the internal configuration of the valve timing adjusting device in accordance with Embodiment 1 of the present invention, taken along the line B-B of FIG. 5;

FIG. 3 is a view of the state where a vane rotor assumes the most advanced angle position with respect to a first rotor, taken along the line III-III of FIG. 1;

FIG. 4 is a view of the state where the vane rotor assumes the most retarded angle position with respect to the first rotor, taken along the line IV-IV of FIG. 1;

FIG. 5 is a view of the state where the vane rotor assumes the most advanced angle position with respect to the first rotor, taken along the line V-V of FIG. 1; and

FIG. 6 is a view of the state where the vane rotor assumes the most retarded angle position with respect to the first rotor, taken along the line VI-VI of FIG. 1.

BEST MODE FOR CARRYING OUT THE INVENTION

[0011]

An embodiment of the present invention will now be described with reference to the drawings in order to make description in further detail of the present invention.

Embodiment 1.

FIG. 1 is an axial sectional view of the internal configuration of a valve timing adjusting device in accordance with Embodiment 1 of the present invention, taken along the line A-A of FIG. 3, which is later described. FIG. 2 is an axial sectional view thereof taken along the line B-B of FIG. 5, later described. FIG. 3 is a radial sectional view of the state where a second rotor assumes the most advanced angle position with respect to a first rotor, taken along the line III-III of FIG. 1. FIG. 4 is a radial sectional view of the state where the second rotor assumes the most retarded angle position with respect to the first rotor, taken along the line IV-IV of FIG. 1. FIG. 5 is a radial sectional view of the state where the second rotor assumes the most advanced angle position with respect to the first rotor, taken along the line V-V of FIG. 1. FIG. 6 is a radial sectional view of the state where the second rotor assumes the most retarded angle position with respect to the first rotor, taken along the line VI-VI of FIG. 1.

[0012]

The valve timing adjusting device 1 according to Embodiment 1 is generally composed of, as shown in FIG. 1 to FIG. 6, a first rotor 3 that rotates synchronizingly with the

crankshaft (not shown) of the engine (not shown) through a chain (not shown); a second rotor 7 that is disposed within this first rotor 3, and is integrally secured on the end face of an intake or exhaust camshaft (hereinafter referred to as simply the camshaft) 5; and an assisting spring (energizing member) 9 for adjusting the relative rotation between this second rotor 7 and the first rotor 3.

[0013]

The first rotor 3 is generally composed of a housing 11 that externally has a sprocket 11a receiving the rotational driving force of the crankshaft (not shown), and that internally has a bearing (not shown) slidingly contacting the outer peripheral surface located in the vicinity of the end face of the camshaft 5; a case 13 that is disposed adjacently to this housing 11, and that internally has a plurality of shoes 13a (three shoes as shown in FIG. 3 to FIG. 6), which radially inwardly project to form a plurality of spaces; and a cover 15 that covers the internal space of this case 13, where these three parts are integrally fastened to each other with a bolt 17.

[0014]

The second rotor 7 is a rotor having a boss 7a integrally fastened on the end face of the camshaft 5, which rotates in the direction shown by the arrow, with a bolt 19 through a washer 18, and a plurality of vanes 7b radially outwardly projecting from the periphery of this boss 7a (hereinafter the second rotor 7 is also referred to as vane rotor 7). Each of the vanes 7b of the vane rotor 7 partitions each of a plurality of internal

spaces formed by the shoes 13a of the case 13 into an advanced-angle hydraulic chamber 21 that receives the supply of the oil pressure when the vane rotor 7 is relatively rotated in the direction of the advanced angle side with respect to the first rotor 3 and an retarded-angle hydraulic chamber 23 that receives the supply of the oil pressure when the vane rotor 7 is relatively rotated in the direction of the retarded angle side with respect to the first rotor 3. One end of a second oil passage 27 formed in the interior of the camshaft 5 is connected to each advanced-angle hydraulic chamber 21, while one end of a first oil passage 25 similarly formed in the interior of the camshaft 5 is connected to each of the retarded-angle hydraulic chambers 23. Each of the other ends of the first oil passage 25 and the second oil passage 27 leads to an oil pump (not shown) and an oil pan (not shown) through an oil-controlling valve (not shown, and hereinafter referred to as OCV).

[0015]

In one shoe 13a of the case 13 provided in this valve timing adjusting device 1, is formed a accommodating hole 29 penetrating the shoe in a radial direction of the device. In this accommodating hole 29, a generally cylindrical lock pin 31 is disposed reciprocally slidably along an axial direction of the accommodating hole. At the bottom of the lock pin 31, which is located on the outside in the radial direction of the pin, a bottomed hole 31a is formed. Moreover, a stopper 33 is inserted into this accommodating hole 29 from the outside of

the radial direction, and the stopper is fixed therein by a shaft 35. The stopper 33 has a bottomed hole 33a inside in the radial direction, and at the bottom of the bottomed hole 33a, there is provided a back-pressure exhausting hole 37 that causes the space within the accommodating hole 29, which axially penetrates the hole and is located behind the lock pin 31, to communicate to the atmosphere. A coil spring 39 for always energizing the lock pin 31 inwardly in a radial direction is provided between the bottomed hole 31a of the lock pin 31 and the bottomed hole 33a of the stopper 33.

[0016]

Meanwhile, in the periphery of the boss 7a of the vane rotor 7, an engaging hole 41 is formed such that the lock pin 31 is advanced inwardly in the radial direction to be engaged by the energizing force of the coil spring 39 when the relative position of the vane rotor 7 with respect to the case 13 is positioned at the most advanced angle position. In addition, a lock-releasing oil passage 42 is provided between this engaging hole 41 and the second oil passage 27.

[0017]

Further, in the vane 7b of the vane rotor 7, which constitutes one sidewall of each retarded-angle hydraulic chamber 23, there is provided a hole 43 accommodating the end 9a of the assisting spring 9 as shown in FIG. 3 to FIG. 6. Similarly, in the shoe 13a of the case 13 which constitutes the other sidewall of each retarded-angle hydraulic chamber 23, there is provided a groove 44 accommodating the other end 9b

of the assisting spring 9 in the side of the shoe opposite to the housing 11, as shown in FIG. 3 to FIG. 6.

[0018]

In the outermost periphery of the vane 7b of the vane rotor 7 and in the innermost periphery of the shoe 13a of the case 13, there are provided sealing means 45, respectively, for preventing the flow of oil between the advanced-angle hydraulic chamber 21 and the retarded-angle hydraulic chamber 23; however, the oil flow may be prevented by reducing the clearances to an extremely small distance.

[0019]

The operation will now be described as below.

On stopping of the engine, the oil remaining in the advanced-angle hydraulic chamber 21 and the retarded-angle hydraulic chamber 23 of the valve timing adjusting device 1 is returned to the oil pan (not shown) via the first oil passage 25, second oil passage 27, and the OCV (not shown). Therefore, the lock pin 31 is engaged in the engaging hole 41 by the energizing force of the coil spring 39, and the relative rotation between the first rotor 3 and the second rotor 7 is restricted at the most advanced angle position (locking state).

[0020]

Then, when the oil pump (not shown) is driven by starting the engine, the oil is supplied from the oil pan (not shown) to the retarded-angle hydraulic chamber 23 of the valve timing adjusting device 1 via the OCV (not shown) and the first oil passage 25. Further, when the advanced-angle oil pressure is

worked on the large diameter portion of the lock pin 31 from the first oil passage 25 via the lock-releasing oil passage 42, the lock pin 31 is thrust back against the energizing force of the coil spring 39 and slipped out of the engaging hole 41. At that time, the first rotor 3 and the vane rotor 7 become relatively rotatable (lock-releasing state). In this state, the assisting spring 9 is arranged to become straight in the vicinity of the point at which the length thereof becomes the maximum as shown in FIG. 3 and FIG. 5.

[0021]

The first rotor 3 and the second rotor 7 in the lock-releasing state are allowed to relatively rotate to the retarded angle side by a predetermined rotation angle against the energizing force of the assisting spring 9 (return force to stationary state) by the retarded-angle oil pressure supplied to the retarded-angle hydraulic chamber 23 at that time.

[0022]

In this lock-releasing state, when the relative position of the vane rotor 7 with respect to the first rotor 3 is caused to move to the retarded angle side or the most retarded angle position, as shown in FIG. 3, the vane rotor 7 is caused to rotate in the direction of the arrow by the retarded-angle oil pressure supplied to the retarded-angle hydraulic chamber 23 against the energizing force (return force to stationary state) of the assisting spring 9. At that time, in the vicinity of the point where the length of the assisting spring 9 shown in FIG. 4 becomes

the minimum, the ratio of the length of the groove or hole (guide length) to the length of the assisting spring 9 increases, thereby reducing the flexure of the assisting spring.

[0023]

As mentioned above, according to Embodiment 1, it is arranged that one end of the energizing means adjusting the relative position between the first rotor and the vane rotor be accommodated in the groove provided in the side of the shoe opposite to the housing, and the other end thereof be accommodated in the groove or hole provided in the vane of the vane rotor. For this reason, the housing has a sufficient thickness and sufficient strength as compared with that of the cover, and the oil pressure does not bend the housing, nor cause the oil leak.

Moreover, the area in which the cover receives the oil pressure does not increase, thereby alleviating the bending of the cover and reducing the oil leak. Thus, the area where the cover receives the oil pressure does not increase, thereby enabling the thin cover or the cover having low strength be used for the valve timing adjusting device.

[0024]

In addition, according to Embodiment 1, the hole accommodating the assisting spring is provided in the side of the vane; however, if a groove accommodating the assisting spring is provided in the opposite side of the vane from the housing as in the case where the groove accommodating the assisting spring is provided in the shoe, the effect similar

to the above-mentioned one can be obtained. Besides, the provision of the groove improves the assembly of the assisting spring as compared with the case of providing the hole accommodating the assisting spring.

[0025]

Further, the assisting spring is arranged to have the maximum length and become straight at the most advanced angle position, thereby reducing the flexure of the assisting spring. Furthermore, when the assisting spring in the most retarded angle position is maximally compressed, the clearance is arranged to be created between the shoe of the first rotor and the vane of the second rotor. This can prevent the assisting spring from bending, and can give the spring freedom to smoothly bend. Moreover, this clearance therebetween can provide the device with constant communication through the oil passage.

[0026]

Embodiment 2.

Three assisting springs are used in Embodiment 1; however, in Embodiment 2, these three assisting springs 9 are arranged to be equally loaded, and to be substantially equiangularly disposed. This configuration can bring the total of the moments due to the fall of the vane rotor 7 close to zero, and can prevent the vane rotor 7, which is orthogonal to the axis, from falling.

INDUSTRIAL APPLICABILITY

[0027]

As mentioned above, the valve timing adjusting device according to the present invention is suitable for preventing the oil leak caused by the flexure of the cover, smoothly operating the device, and controlling opening and closing timings of the intake valve or the exhaust valve of the engine.